BAIGENT GEOSCIENCES

Mithril Resources NL
Geophysical Survey
Processing Report

June 2011

Project: Tibbs & Basil

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1. Datum Specification

The output survey coordinates are based on the Geocentric Datum of Australia 1994 (GDA94), zone 53.

It has the following parameters:

Projection name:	Map Grid of Australia
Datum:	Geocentric Datum of Australia (GDA94)
Reference Frame:	ITRF92 (International Terrestrial Reference 1992)
Epoch:	1994.0
Ellipsoid:	GRS80
Semi-major axis:	6.378.137.0 metres
Inverse flattening:	298,257222101
False Northing:	10,000,000 m N
False Easting:	500,000 m E
Scale Factor:	0.9996

2. Parallax

Parallax corrections were applied as follows:

1. variable fiducials for magnetics data.
2. 0.5 fiducials for radiometric data.
3. variable fiducials for dtm

3. Magnetic processing

3.1 Processing Flow

The diurnal base station data was checked for spikes and steps, and suitably filtered prior to the removal of diurnal variations from the aircraft magnetic data.

The diurnal data was filtered with a second difference filter to identify and remove spikes of less than 0.05nT. A second smoothing filter, a 13 point moving average filter is used to reduce noise levels.

The filtered diurnal are then applied to the survey data by synchronising the diurnal data time with the aircraft survey time. The average diurnal base station value was added to the survey data.

An eighth difference filter was run on the raw magnetic survey data in order to identify any remaining spikes in the data, which were manually edited from the data.

The X and Y positioning of the data was then checked for spikes before applying the IGRF correction. Any spikes in the positions were manually edited.

The IGRF 2010 (updated to 2011.44) correction was calculated at each data point taking into account the height above sea level using a constant altitude. This regional magnetic gradient was subtracted from the survey data points.

The data was then tie-line levelled and micro-levelled.

3.2 Compensation

The data was delivered already compensated and filtered.

3.3 Diurnal Base Value

The average diurnal base value was 53,147.48 nT

3.4 Magnetic Model

IGRF was removed using a constant height 0 kms above sea level.
The magnetic model for the centre of each area is detailed below:

Model	IGRF 2010 updated to 2011.44
Declination	5.2354 degrees
Inclination	-54.8813 degrees
Field strength	52839.42 nT
Grid zone	53
Grid central meridian	135.00000 degrees
Input latitude	-23.32729 degrees
Input longitude	135.31128 degrees
Grid convergence	0.12326 degrees
Grid magnetic angle	5.35871 degrees
Secular variation	-0.03819 degrees

3.5 Tie Line levelling Method

Tie line levelling was applied to the data by least squares minimisation, using a polynomial fit of order 0, of the differences in elevation values at the crossover points of the survey traverse and tie line data.

The least squares tie line levelling process employs a two pass Gauss-Seidel iterative scheme. The essential steps in this process are:

In the first pass the tie lines were first adjusted to minimise, in the least squares sense, the crossover values with the traverse line values being held constant.

The second pass held the levelled tied line values constant, and minimised in the least squares sense, the crossover values with traverses.

The DC correction values are then applied to the traverse line and tie line data.

To reduce the effects of radar altimeter and gps errors on the recorded elevation data at the crossover points, data having a radar altimeter difference greater than 100 metres in a radius of 100 metres on the traverse or tie lines were excluded from the tying process.

3.6 Micro-levelling Method

Micro-levelling techniques were then selectively applied to the tie line levelled data to remove minor residual variations in profile intensity Selective micro-levelling was applied in order to leave unaffected any data having no residual levelling artefacts. Selective micro-levelling proceeds using the following steps:

Areas of interest that required micro-levelling were identified through the use of image processing visualisation.

Polygons were used to define areas requiring micro-levelling.

“Pseudo-ties” were constructed from the gridded data by extracting traverses from the grid normal to the flight direction.

Line dependent artefacts were removed from the pseudo lines using custom filters.

Crossover values were calculated between traverse lines and pseudo tie lines.

The traverse lines were adjusted in the pre-defined sections to minimise the crossover values.

This process was repeated in order to remove various wavelength line dependent artefacts from the pseudo-ties. The object of each micro-levelling iteration was to produce a smooth control surface to which the traverse lines are levelled. This control surface was provided through the use of “pseudo-ties”.

3.7 Interpolation Method

The interpolation used is a minimum curvature algorithm. The algorithm is based on the worked published by Briggs 1974, Briggs I. C.: Machine contouring using minimum curvature. *Geophysics*. Vol. 39, No. 1. February 1974. pp. 39-48.

The algorithm has been modified to include a tension parameter based on the work published by Smith and Wessel Smith, W. H. F, and P. Wessel, 1990, Gridding with continuous curvature splines in tension, Geophysics 55, 293-305.

A tension factor of 0 was used to interpolate the magnetics

The mesh size for data interpolation was 10 x 10 metres.

4. Radiometric Processing

4.1 Processing Flow

The processing steps radiometric data were as follows:

1. Application of necessary parallax corrections to data
2. Check radar altimeter data for spikes
3. NASVD spectral smoothing
   - Examine the output to determine the number of components required.
   - Select 8 components for spectral reconstruction.
4. Standard 256 channel radiometric corrections:
   - Dead-time correction performed on 256 channel data.
   - Check if energy recalibration required
   - Remove background radon from window data using Minty's method (1996)
   - Perform STP height corrected spectral stripping
   - Perform STP height correction of window data to average survey height (40 m).
5. Micro-levelling

Spectral smoothing was applied using the NASVD process, and spectral reconstruction was employed using 8 spectral components.

Micro-levelling was applied in the method as described below.

4.2 Window Energy Limits

The energy bounds for the windows were

Window Name	Energy Range (Mev)
Potassium	1.374 – 1.566
Thorium	2.416 – 2.799
Uranium	1.662 – 1.854
Total Count	0.414 – 2.799

4.3 Spectral Stripping Ratios

The stripping ratios used in the processing were:

Alpha	0.277
Beta	0.408
Gamma	0.776
a	0.045
b	0.001
g	0.000

4.4 Tie Line Levelling

No tie line levelling was applied.

4.5 Micro-levelling Method

Micro-levelling techniques were then selectively applied to the tie line levelled data to remove minor residual variations in profile intensity Selective micro-levelling was applied in order to leave unaffected any data having no residual levelling artefacts. Selective micro-levelling proceeds using the following steps:

Areas of interest that required micro-levelling were identified through the use of image processing visualisation.

Polygons were used to define areas requiring micro-levelling.

"Pseudo-ties" were constructed from the gridded data by extracting traverses from the grid normal to the flight direction.

Line dependent artefacts were removed from the pseudo lines using custom filters.

Crossover values were calculated between traverse lines and pseudo tie lines.

The traverse lines were adjusted in the pre-defined sections to minimise the crossover values.

This process was repeated in order to remove various wavelength line dependent artefacts from the pseudo-ties. The object of each micro-levelling iteration was to produce a smooth control surface to which the traverse lines are levelled. This control surface was provided through the use of "pseudo-ties".

4.6 Interpolation Method

The interpolation used is a minimum curvature algorithm. The algorithm is based on the worked published by Briggs 1974, Briggs I. C.: Machine contouring using minimum curvature. *Geophysics*. Vol. 39, No. 1. February 1974. pp. 39-48.

The algorithm has been modified to include a tension parameter based on the work published by Smith and Wessel Smith, W. H. F, and P. Wessel, 1990, Gridding with continuous curvature splines in tension, Geophysics 55, 293-305.

A tension factor of 0 was used to interpolate the radiometrics.

The mesh size for data interpolation was 10 x 10 metres.

5. Elevation Processing

5.1 Processing Flow

The processing steps for digital elevation data were as follows:

1. Application of necessary parallax corrections to data
2. Calculation of raw digital elevation data by subtracting the radar altimeter from the gps altitude
3. Tie line levelling
4. Micro-levelling

5.2 Tie Line levelling Method

Tie line levelling was applied to the data by least squares minimisation, using a polynomial fit of order 0, of the differences in elevation values at the crossover points of the survey traverse and tie line data.

The least squares tie line levelling process employs a two pass Gauss-Seidel iterative scheme. The essential steps in this process are:

In the first pass the tie lines were first adjusted to minimise, in the least squares sense, the crossover values with the traverse line values being held constant.

The second pass held the levelled tied line values constant, and minimised in the least squares sense, the crossover values with traverses.

The DC correction values to be applied to the traverse lines and tie lines were then applied to the magnetic data.

To reduce the effects of radar altimeter and gps errors on the recorded elevation data at the crossover points, data having a radar altimeter difference greater than 10 metres in a radius of 100 metres on the traverse or tie lines were excluded from the tying process.

5.3 Micro-levelling Method

Micro-levelling techniques were then selectively applied to the tie line levelled data to remove minor residual variations in profile intensity Selective micro-levelling was applied in order to leave unaffected any data having no residual levelling artefacts. Selective micro-levelling proceeds using the following steps:

Areas of interest that required micro-levelling were identified through the use of image processing visualisation.

Polygons were used to define areas requiring micro-levelling.

“Pseudo-ties” were constructed from the gridded data by extracting traverses from the grid normal to the flight direction.

Line dependent artefacts were removed from the pseudo lines using custom filters.

Crossover values were calculated between traverse lines and pseudo tie lines.

The traverse lines were adjusted in the pre-defined sections to minimise the crossover values.

This process was repeated in order to remove various wavelength line dependent artefacts from the pseudo-ties. The object of each micro-levelling iteration was to produce a smooth control surface to which the traverse lines are levelled. This control surface was provided through the use of "pseudo-ties".

5.4 Adjust to AHD

N values were removed in real time in the GPS receiver.

5.5 Interpolation Method

The interpolation used is a minimum curvature algorithm. The algorithm is based on the worked published by Briggs 1974, Briggs I. C.: Machine contouring using minimum curvature. *Geophysics*. Vol. 39, No. 1. February 1974. pp. 39-48.

The algorithm has been modified to include a tension parameter based on the work published by Smith and Wessel Smith, W. H. F, and P. Wessel, 1990, Gridding with continuous curvature splines in tension, Geophysics 55, 293-305.

A tension factor of 0 was used to interpolate the dtm.

The mesh size for data interpolation was 10 x 10 metres.

6. Deliverable Items

The deliverable items included all digital data. The located data conformed to ASEG-GDF format and the gridded data was suppled in ERMapper format. The description of the located data is below:

There were three areas's supplied:

Tibbs
Basil

Located data supplied in ASEG GDF

File name	Definition
*_magdtm	Raw magnetics & elevation data
* _rad256	Raw 256 channel data
* _rads	Final Radiometric Window Data

Gridded data supplied in ER Mapper format

File name	Definition	Units
* _TMI	Final magnetic gridded data	nT
* _ELEV	Final elevation gridded data	m
* _TOT	Final radiometric dose rate gridded data	CPS
* _POT	Final radiometric potassium gridded data	CPS
* _TH	Final radiometric uranium gridded data	CPS
* _URA	Final radiometric thorium gridded data	CPS

* Denotes the area name as described above

6.1 Final Magnetic Located Data file

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```
COMM
COMM  Baigent Geosciences Pty. Ltd.
COMM  ----------------------------
COMM
COMM  LOCATED DATA
COMM  -------------
COMM Area  :  Mithril Resources
COMM Company Flown by:   Daishsat Pty. Ltd.
COMM Company Flown for:  Tibbs & Basil
COMM Company Processed:  Baigent Geosciences Pty. Ltd.
COMM
COMM AIRBORNE SURVEY EQUIPMENT:
COMM -------------------------
COMM
COMM Aircraft                         : Robinson R44
COMM Magnetometer                     : Geometrics G822 Cesium  Vapour
COMM Magnetometer Resolution          : 0.001 nT
COMM Magnetometer Compensation        : Post Flight
COMM Magnetometer Sample Interval     : 10 Hz, Approx 2.2 metres
COMM Data Acquisition                 : GeoOZ Model 2009
COMM Spectrometer                     : Radiation Solutions RS 500
COMM Crystal Size                     : 16 lt downward array
COMM Spectrometer Sample Interval     : 1.0 Seconds (approx 44 metres)
COMM GPS Navigation System            : Novatel 951R GPS Receiver
COMM
COMM
COMM
COMM AIRBORNE SURVEY SPECIFICATIONS
COMM
COMM Tibbs
COMM Flight Line Direction            :    090 - 270  degrees
COMM Flight Line Separation           :           50  metres
COMM Tie Line Direction               :    000 - 180  degrees
COMM Tie Line Separation              :           500 metres
COMM Basil
COMM Flight Line Direction            :    030 - 210  degrees
COMM Flight Line Separation           :           50  metres
COMM Tie Line Direction               :    120 - 300  degrees
COMM Tie Line Separation              :           500 metres
COMM Terrain Clearance                :       40 metres (MTC)
COMM
COMM
COMM Survey flown                     :             June 2011
COMM
COMM
COMM FFlight path calculated from GPS data with no differential correction.
COMM
COMM
COMM Grid notation refers to GDA/MGA Zone  53
COMM
COMM
COMM MAGNETIC DATA CORRECTIONS:
```

```
COMM -------------------------
COMM Diurnal variations removed
COMM IGRF(2011) updated to 2011.44 removed
COMM Average survey base station value added to datum
COMM
COMM RADIOMETRIC CORRECTIONS AND COEFFICIENTS:
COMM ----------------------------------------
COMM Data has been corrected for aircraft and cosmic backgrounds.
COMM Height corrected to a constant datum of 40 metres,
COMM minimum height of 10 and a maximum of 300 metres.
COMM Data has also been corrected for radon using the method described by Minty
COMM and corrected for channel interaction.
COMM
COMM                    Tot.Count    Potassium   Uranium     Thorium
COMM Arcft Bkg             26.6         10.37        0           0
COMM Cosmic Bkg           0.986        0.0514      0.041       0.0549
COMM Height Attn         0.007434    0.009432     0.008428    0.007510
COMM
COMM
COMM STRIPPING RATIOS:
COMM ----------------
COMM   Alpha = 0.269,  Beta = 0.404, Gamma = 0.758,
COMM   a = 0.056,  b = 0.004,  g = -0.001
COMM
COMM
COMM                    Channel name           Format            Units       Null
Value
COMM_____________________________________________________________________________
_______
COMM
COMM                        Job code              A5
COMM                       Line number            A9
COMM                            Flight            I5
COMM                       Flight date            A9    YYYYMMDD
COMM                          fiducial          f12.1              -999999.000000
COMM                          mga_east          f11.2    METRES     -99999.000000
COMM                         mga_north          f11.2    METRES    -99999.000000
COMM                          gda_long          f12.6    degrees      -999.000000
COMM                           gda_lat          f11.6    degrees       -99.000000
COMM                           rad_alt           f8.2    METRES       -999.000000
COMM                        gps_height           f8.2    METRES       -999.000000
COMM                           raw_mag          f10.3    nT          -9999.000000
COMM                         mag_gammas         f10.3    nT          -9999.000000
COMM                      diurnal_gammas        f10.3    nT          -9999.000000
COMM                         igrf_gammas        f10.3    nT          -9999.000000
COMM                           fin_mag          f10.3    nT          -9999.000000
COMM                               dtm           f8.2    METRES       -99.000000
```

6.2 Final Radiometric Located Data file

.

```
COMM
COMM  Baigent Geosciences Pty. Ltd.
COMM  ----------------------------
COMM
COMM  LOCATED DATA
COMM  -------------
```

```
COMM Area  :  Mithril Resources
COMM Company Flown by:   Daishsat Pty. Ltd.
COMM Company Flown for:  Tibbs & Basil
COMM Company Processed:  Baigent Geosciences Pty. Ltd.
COMM
COMM AIRBORNE SURVEY EQUIPMENT:
COMM -------------------------
COMM
COMM Aircraft                          : Robinson R44
COMM Magnetometer                      : Geometrics G822 Cesium  Vapour
COMM Magnetometer Resolution           : 0.001 nT
COMM Magnetometer Compensation         : Post Flight
COMM Magnetometer Sample Interval      : 10 Hz, Approx 2.2 metres
COMM Data Acquisition                  : GeoOZ Model 2009
COMM Spectrometer                      : Radiation Solutions RS 500
COMM Crystal Size                      : 16 lt downward array
COMM Spectrometer Sample Interval      : 1.0 Seconds (approx 44 metres)
COMM GPS Navigation System             : Novatel 951R GPS Receiver
COMM
COMM
COMM
COMM AIRBORNE SURVEY SPECIFICATIONS
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COMM Tibbs
COMM Flight Line Direction             :    090 - 270  degrees
COMM Flight Line Separation            :           50  metres
COMM Tie Line Direction                :    000 - 180  degrees
COMM Tie Line Separation               :           500 metres
COMM Basil
COMM Flight Line Direction             :    030 - 210  degrees
COMM Flight Line Separation            :           50  metres
COMM Tie Line Direction                :    120 - 300  degrees
COMM Tie Line Separation               :           500 metres
COMM Terrain Clearance                 :       40 metres (MTC)
COMM
COMM
COMM Survey flown                      :             June 2011
COMM
COMM
COMM FFlight path calculated from GPS data with no differential correction.
COMM
COMM
COMM Grid notation refers to GDA/MGA Zone  53
COMM
COMM
COMM MAGNETIC DATA CORRECTIONS:
COMM -------------------------
COMM Diurnal variations removed
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COMM
COMM                    Tot.Count    Potassium   Uranium     Thorium
COMM Arcft Bkg             26.6         10.37        0           0
```

```
COMM Cosmic Bkg          0.986        0.0514      0.041       0.0549
COMM Height Attn        0.007434    0.009432     0.008428    0.007510
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COMM STRIPPING RATIOS:
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COMM   Alpha = 0.269,  Beta = 0.404, Gamma = 0.758,
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COMM
COMM
COMM                   Channel name           Format            Units       Null
Value
COMM_____________________________________________________________________________
_______
COMM
COMM                       Job code              A5
COMM                     Line number             A9
COMM                          Flight             I5
COMM                     Flight date             A9    YYYYMMDD
COMM                        fiducial           f12.1              -999999.000000
COMM                        mga_east           f11.2    METRES     -99999.000000
COMM                       mga_north           f11.2    METRES     -99999.000000
COMM                        gda_long           f12.6    degrees      -999.000000
COMM                         gda_lat           f11.6    degrees       -99.000000
COMM                         rad_alt            f8.2    METRES       -999.000000
COMM                      gps_height            f8.2    METRES       -999.000000
COMM                    baro_pressure           f8.2    hPa          -999.000000
COMM                   temp_air_deg_c           f5.1    DEGC           -9.000000
COMM                        live_time           f6.0    MSEC           -9.000000
COMM                      raw_tot_cps           f8.0    CPS           -99.000000
COMM                      raw_pot_cps           f7.0    CPS           -99.000000
COMM                      raw_ura_cps           f7.0    CPS           -99.000000
COMM                       raw_th_cps           f7.0    CPS           -99.000000
COMM                      cosmicd_cps           f5.0    CPS          -999.000000
COMM                      fin_tot_cps           f8.1    CPS           -99.000000
COMM                      fin_pot_cps           f7.1    CPS           -99.000000
COMM                      fin_ura_cps           f7.1    CPS           -99.000000
COMM                       fin_th_cps           f7.1    CPS           -99.000000
COMM
```

6.3 Final 256 Radiometric Data

.

```
COMM
COMM  Baigent Geosciences Pty. Ltd.
COMM  -----------------------------
COMM
COMM  LOCATED DATA
COMM  -------------
COMM Area  :  Mithril Resources
COMM Company Flown by:   Daishsat Pty. Ltd.
COMM Company Flown for:  Tibbs & Basil
COMM Company Processed:  Baigent Geosciences Pty. Ltd.
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COMM AIRBORNE SURVEY EQUIPMENT:
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COMM
```

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COMM Magnetometer Resolution           : 0.001 nT
COMM Magnetometer Compensation         : Post Flight
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COMM Spectrometer                      : Radiation Solutions RS 500
COMM Crystal Size                      : 16 lt downward array
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COMM Flight Line Separation            :           50  metres
COMM Tie Line Direction                :    120 - 300  degrees
COMM Tie Line Separation               :           500 metres
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COMM
COMM
COMM Survey flown                      :             June 2011
COMM
COMM
COMM Flight path calculated from GPS data with no differential correction.
COMM
COMM
COMM Grid notation refers to GDA/MGA Zone  53
COMM
COMM
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COMM IGRF(2011) updated to 2011.44 removed
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COMM Cosmic Bkg           0.986        0.0514      0.041       0.0549
COMM Height Attn         0.007434    0.009432     0.008428    0.007510
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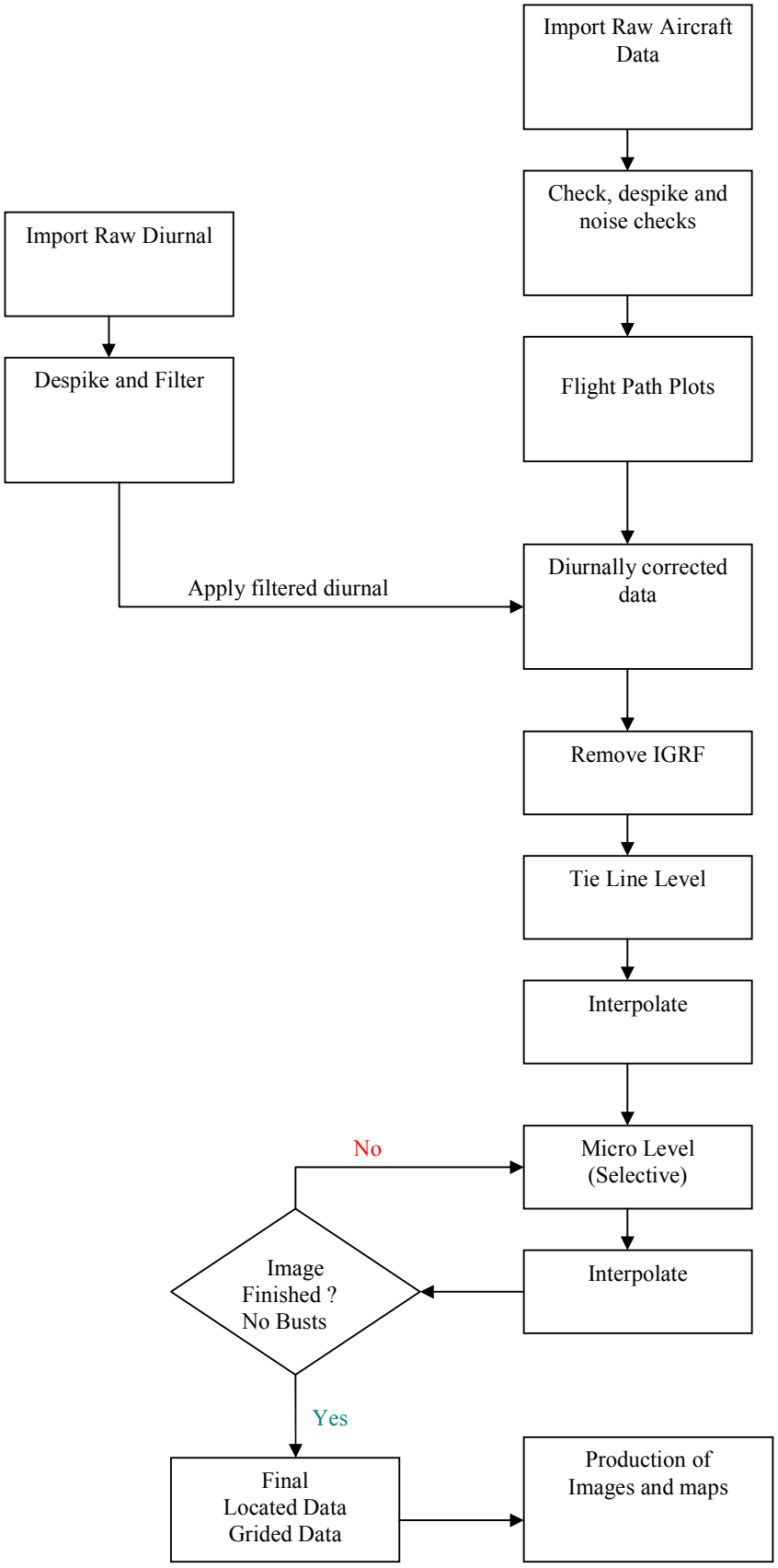
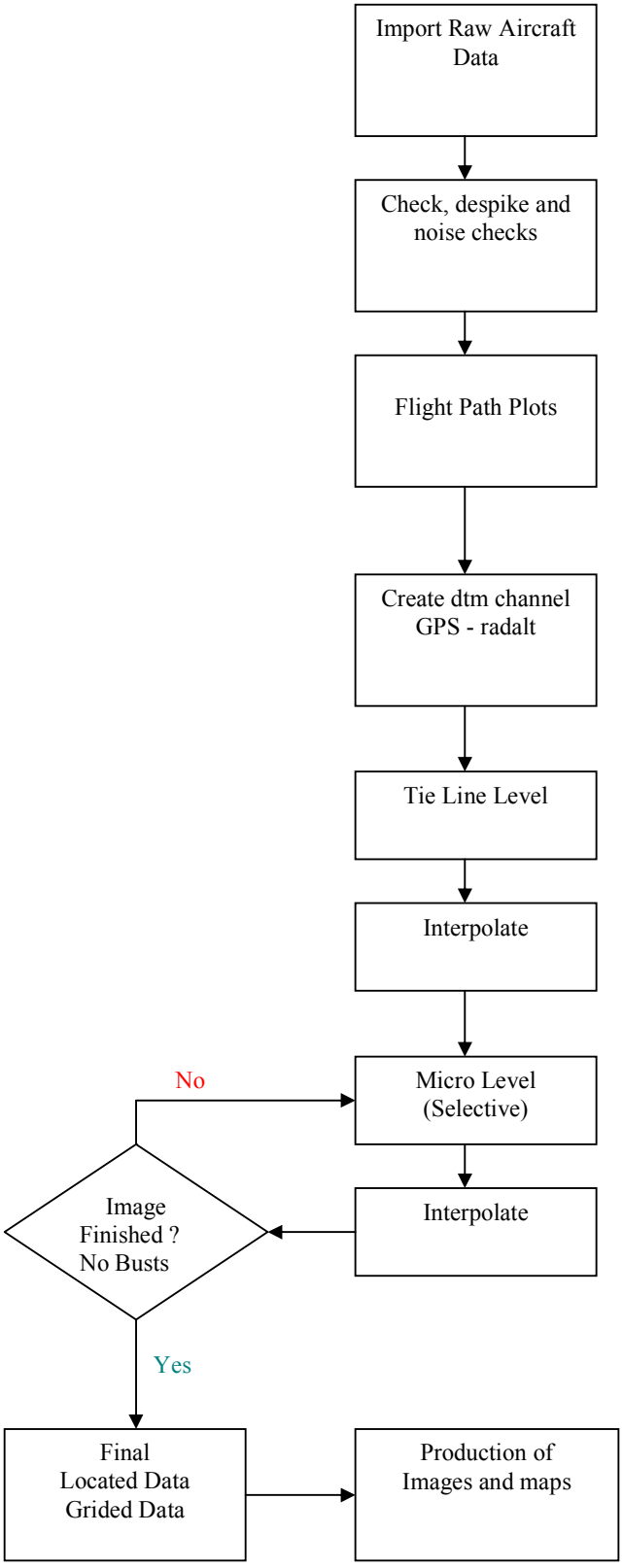
COMM
COMM STRIPPING RATIOS:
COMM ----------------
COMM   Alpha = 0.269,  Beta = 0.404, Gamma = 0.758,
COMM   a = 0.056,  b = 0.004,  g = -0.001
```

```
COMM
COMM
COMM                    Channel name           Format            Units       Null
Value
COMM_____________________________________________________________________________
COMM
COMM                        Job code              A5
COMM                     Line number              A9
COMM                          Flight              I5
COMM                     Flight date              A9    YYYYMMDD
COMM                        fiducial           f12.1             -999999.000000
COMM                        mga_east           f11.2    METRES    -99999.000000
COMM                       mga_north           f11.2    METRES    -99999.000000
COMM                        gda_long           f12.6    degrees     -999.000000
COMM                         gda_lat           f11.6    degrees      -99.000000
COMM                         rad_alt            f8.2    METRES      -999.000000
COMM                      gps_height            f8.2    METRES      -999.000000
COMM                    baro_pressure           f8.2    hPa         -999.000000
COMM                   temp_air_deg_c           f5.1    DEGC          -9.000000
COMM                        live_time           f6.0    MSEC          -9.000000
COMM                      cosmicd_cps           f5.0    CPS         -999.000000
COMM         raw 256 channl spectra           256i5    CPS           -9
COMM
```

7. Magnetic Data Processing Flow Chart



8. Elevation Data Processing Flow Chart



9. Radiometric Processing Flow Chart